Docket No.: USS-18302/16

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Subhendu Guha et al.

Application No.: 10/765,435 | Confirmation No.: 1518

Filed: January 27, 2004 | Art Unit: 2822

For: METHOD FOR DEPOSITING HIGH-QUALITY MICROCRYSTALLINE SEMICONDUCTOR MATERIALS | Examiner: T. Y. Tran

APPEAL BRIEF

MS Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

As required under § 41.37(a), this brief is filed within two months of the Notice of Appeal filed in this case on August 31, 2006, and is in furtherance of said Notice of Appeal.

The fees required under § 41.20(b)(2) are dealt with in the accompanying TRANSMITTAL OF APPEAL BRIEF.

This brief contains items under the following headings as required by 37 C.F.R. § 41.37 and M.P.E.P. § 1206:

I. REAL PARTY IN INTEREST

Appellant identifies United Solar Systems Corporation, a corporation organized under the laws of the State of Michigan and having its principal place of business at 1100 West Maple Road, Troy, Michigan 48084, and assignee of the subject patent application as the real party in interest.

II. RELATED APPEALS, INTERFERENCES, AND JUDICIAL PROCEEDINGS

Appellants, Appellants' legal representative, and assignee are aware of no prior and/or pending appeals, interferences or judicial proceedings which are related to, directly affect or would be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

The present application was originally filed with 21 claims. Claims 15-21 were canceled by Appellants in response to a restriction requirement. Claims 1-14 remain pending and all have been finally rejected.

In a final Office Action dated June 7, 2006, the Examiner finally rejected claims 1-8, 11 and 13-14 under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 6,274,461 to Guha et al. (the Board will note that the inventors of the '461 patent are Guha and Yang, two of the three coinventors of the present invention).

There are also two final rejections based on 35 U.S.C. §103(a), namely a rejection of claims 8-9 as obvious over the combination of Guha et al. '461 and U.S. Published Patent Application No. 2003/0036090 A1 (Patil et al.), as well as a rejection of claim 12 as obvious over Guha '461 and U.S. Patent No. 5,786,023 to Maxwell et al.

Claim 1 is an independent claim and all of claims 2-14 ultimately depend upon it. Accordingly, Appellants are appealing the final rejection of all 14 claims. It is Appellants' contention that independent claim 1 is neither anticipated by Guha et al. nor obvious over it, either considered alone or in combination with Patil et al. and/or Maxwell et al., or any other references of record. Accordingly, all claims are patentable.

IV. STATUS OF AMENDMENTS

No amendments to the claims were filed subsequent to final rejection.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 1 is directed to a process for the plasma deposition of a layer of microcrystalline semiconductor material (specification, page 9, lines 4-5). A process gas which includes a precursor of the semiconductor material and a diluent is energized with electromagnetic energy so as to create a plasma therefrom (specification, page 9, lines 5-7). The plasma which is created therefrom deposits a layer of microcrystalline semiconductor material onto a substrate (specification, page 9, lines 7-9). The claimed improvement comprises varying the concentration of the diluent in said process gas as a function of the thickness of the layer of microcrystalline semiconductor material which has been deposited (specification, page 9, lines 9-11).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. <u>The §102(b) Rejection over Guha et al. '461</u>.

The rejection of the sole independent claim pending in the application, claim 1, was initially made in a first Office Action dated December 14, 2005. According to the Examiner:

> As to claim 1, Guha et al teaches in figures 1-2 a process for the plasma deposition of layer of microcrystalline semiconductor

> material, wherein a process gas which includes a precursor of the semiconductor material and a diluent is energized with electromagnetic energy so as to create a plasma therefrom, which plasma deposits a layer of the microcrystalline semiconductor material onto a substrate (see col. 2, lines 43-61), wherein the improvement comprises: varying the concentration of the diluent in the process gas as a function of the thickness of the layer of microcrystalline semiconductor material which has been deposited (see col. 6, lines 20-53).

Dependent claims 2-8, 11 and 13-14 were also rejected in the initial Office Action as anticipated by Guha et al. '461. However, since Appellants are not separately arguing the patentability of any of the independent claims, the Examiner's applications of various teachings from Guha et al. as applied to these dependent claims will not be detailed in this brief.

In an amendatory response dated March 14, 2006, Appellants took issue with the §102(b) rejection over Guha et al. It was Appellants' contention that the Examiner had misinterpreted the '461 patent because this patent is not directed to the preparation of a microcrystalline material. In actuality, Appellants contended, "The '461 patent is specifically directed to the preparation of high quality amorphous semiconductor materials, and in that regard specifically teaches a deposition process optimized to **avoid the deposition of a microcrystalline semiconductor material**." The amendatory response then went on to amplify on this argument, as will be amplified in detail in Section VII of this Brief.

In response to Appellants' arguments, the Examiner responded in the final Office Action in the following manner:

> Applicant argued that the patent No. US 6,274,461 teaches away from the present invention and is not directed to the preparation of a microcrystalline material. In response, the examiner disagrees with applicant's argument because the patent No. US 6,274,461 of Guha et al clearly teaches a process for the plasma deposition of a layer of semiconductor material, wherein the deposited

> semiconductor material is amorphous <u>or microcrystalline</u> (see col. 2, lines 43-61).

In a Response under Rule 116 dated August 7, 2006, Appellants pointed out to the Examiner that, while the Guha et al. reference in the passage cited by the Examiner acknowledges that plasma deposition processes may be operated so as to produce amorphous or microcrystalline materials (as is well known in the prior art), the Guha '461 patent teaches selecting the parameters of the deposition process so that the process operates near, but below the amorphous-microcrystalline threshold so as to produce an amorphous material. Furthermore, as Appellants pointed out, the reference also teaches the superior quality of the amorphous material produced by maintaining these deposition conditions.

In an Advisory Action dated August 25, 2006, the Examiner responded by essentially repeating the prior rejection as follows:

> the claimed invention read on the structure and the corresponding method of Guha et al (U.S. 6,274,461). For example, applicant argued that Guha does not teach a layer of microcrystalline semiconductor material that is deposited onto a substrate. In response, the examiner disagrees with applicant's argument because Guha et al clearly teaches in col. 2, lines 43-61 a layer of microcrystalline semiconductor material that is plasma deposited onto a substrate. Thus, applicant's arguments have been considered but they are not persuasive.

Thus, the present appeal turns on the issue of whether or not the passage from Guha cited by the Examiner teaches the method of claim 1. It is Appellants' contention that this is not the case and that the Examiner has misunderstood and misapplied the teachings of Guha et al. to make an improper anticipatory rejection.

B. <u>The §103 Obviousness Rejections</u>.

The two §103(a) obviousness rejections of dependent claims 9-10 over the combination of Guha et al. and Patil et al. and of claim 12 over Guha et al. and Maxwell et al. will also not be discussed in detail. Suffice it to say that the rejections applied to all 14 pending claims set forth in the initial Office Action were repeated verbatim in the final Office Action of June 7, 2006.

Appellants understand that because Appellants are not separately arguing the patentability of dependent claims 2-14, they will stand or fall with the patentability of independent claim 1.

VII. ARGUMENT

A. <u>The Guha et al. '461 Patent</u>.

Appellants were well aware, of course, of the teachings of their own prior art patent. In fact, teachings from this patent and their applicability to the present invention are discussed in considerable detail starting at page 6 of the specification, first full paragraph and continuing on to the paragraph bridging pages 8 and 9. Appellants will briefly recapitulate the principles of the present invention so as to better differentiate it from the cited prior art.

The invention, as is specifically claimed, is directed to a method for the plasma deposition of a high quality layer of microcrystalline semiconductor material. As described in the specification, microcrystalline semiconductor materials have particular advantages at certain applications; however, the electrical quality of these materials is very dependent upon their morphology. In general, microcrystalline materials exhibiting columnar growth, large grain sizes, high defect grain boundaries and the like, often manifest poor electrical performance in semiconductor devices. The present invention recognizes that in a plasma deposition process in

which electromagnetic energy is used to decompose a process gas and deposit a semiconductor material, the degree of dilution of that process gas must be varied as a thickness of the deposited layer increases. As will be explained hereinbelow, the prior art has not recognized this fact and does not show nor suggest any deposition process in accord with the claims at issue.

As stated earlier, it is Appellants' contention that the Examiner has misinterpreted the '461 patent, and such is evidenced by the specific passage referred to by the Examiner. The referred-to passage (column 2, lines 43-61) of Guha describes a plasma deposition process and states:

> The present invention is directed to a process for the plasma deposition of a layer of semiconductor material. In general, such process energizes a process gas, which includes a precursor of the semiconductor material, with electromagnetic energy so as to create a plasma therefrom. The plasma deposits a layer of semiconductor material onto a substrate maintained in proximity thereto. The deposition parameters of the process, which include process gas composition, process gas pressure, power density of the electromagnetic energy and substrate temperature, will determine whether the deposited semiconductor material is amorphous or microcrystalline; and most preferably, deposition is carried out under conditions just below the amorphous/microcrystalline threshold so as to produce a relatively ordered amorphous material. In accord with the present invention, deposition parameters are controlled so as to maintain the deposition process at amorphous microcrystalline threshold throughout the entire deposition of the layer.

Thus, the Guha et al. patent is specifically directed to the preparation of high quality amorphous semiconductor materials, specifically teaching a deposition process optimized to avoid the deposition of a microcrystalline semiconductor material.

This is made very clear from the explicit language of the '461 patent. For example, at column 1, lines 54-59, the '461 patent states "it has been found that the best devices are manufactured when photogenerative material (for example the intrinsic layer in a P-I-N device)

is amorphous, but is prepared from material obtained under deposition conditions just below the threshold of microcrystalline growth" (citation omitted). The patent goes on to specifically teach away from the desirability of using microcrystalline materials in photovoltaic devices and, in this regard, at column 2, lines 9-16 teaches that open circuit voltage of a photovoltaic device decreases as the material becomes microcrystalline, and further that the presence of grain boundaries in a microcrystalline material adversely affects the performance of the photovoltaic device.

As specifically proposed in the '461 patent, semiconductor materials for photovoltaic devices having optimum performance characteristics are prepared from material which is amorphous but is manufactured under a series of deposition parameters which are in the amorphous deposition regime but nearer to the threshold at which the deposition process begins to produce microcrystalline materials. Accordingly, the '461 patent teaches (1) the deposition of amorphous materials and (2) the desirability of avoiding the deposition of microcrystalline materials. Hence, the '461 patent specifically teaches away from the principles of the present invention, which invention is directed to methods for the preparation of microcrystalline semiconductor materials. This is made very clear in the passage referred to by the Examiner at column 2, lines 54-57, wherein it is specifically stated that the process of the Guha et al. patent is carried out "so as to produce relatively ordered amorphous material."

This patent also teaches that it is necessary to decrease the dilution of the process gas as an amorphous semiconductor layer is grown so as to keep that layer amorphous and prevent it from becoming microcrystalline. In this regard, see column 6, lines 39-44. In sharp contrast, the present invention operates to prepare a microcrystalline semiconductor layer and teaches that it is

necessary to decrease the dilution of the process gas as the microcrystalline layer grows so as to maintain the deposition of a high quality microcrystalline layer.

In short, the teaching of Guha et al. '461 is that a superior quality **amorphous material** is prepared by maintaining deposition conditions near, but below, the amorphous/microcrystalline threshold. There is no teaching in Guha '461 of processes for preparing superior microcrystalline materials by controlling deposition parameters in accord with the claims at issue. The mere fact that Guha '461 acknowledges that the microcrystalline materials can be made does not anticipate or make obvious the present claimed invention.

B. The Guha et al. Reference Fails to Teach the Invention of Claim 1.

As has been shown above, the most that the Guha reference can be said to teach is that the process parameters of plasma deposition can be manipulated to either produce amorphous or microcrystalline layers of semiconductor material, and this is only in the context of teaching control of the process parameters to keep them just above the amorphous/microcrystalline boundary so as to produce amorphous (but not microcrystalline) layers. Such a teaching is quite far from the Examiner's contention in her Advisory Action that "Guha et al clearly teaches in col. 2, lines 43-61 a layer of microcrystalline semiconductor material that is plasma deposited onto a substrate." What the reference taken as a whole actually teaches is the high desirability of depositing a layer of amorphous material and, in the passage the Examiner specifically cites, teaches the broad concept of manipulating the process parameters of the plasma deposition process so as to produce the desired amorphous layers. Much of the remainder of the patent is devoted to teaching the details on how to do that.

But even if the Examiner were correct in her contention that the cited passage of Guha (or anything else in the reference) teaches "a layer of microcrystalline semiconductor material that is

plasma deposited onto a substrate," this would clearly not be enough to defeat Appellants' claim 1, and certainly not under §102(b) because claim 1 does not claim "a layer of microcrystalline semiconductor material that is plasma deposited onto a substrate."

This is refuted by the very structure of claim 1. The preamble of the claim (which is Jepson format) contains the clause "which plasma deposits a layer of said microcrystalline semiconductor material onto a substrate," something Appellants acknowledge is in the prior art. Indeed, the specification of the present invention actually incorporates by reference the entire disclosure of the '461 patent. So if claim 1 were nothing more than its preamble, the Examiner would have a much stronger position.

However, claim 1 specifically states that its claimed improvement comprises: "varying the concentration of the diluent in said process gas as a function of the thickness of the layer of microcrystalline semiconductor material which has been deposited." Page 11, lines 8-15 of the specification help illuminate how this is accomplished:

> In accord with the present invention, it has been found that the material quality of plasma deposited microcrystalline semiconductor materials may be controlled by controlling the composition of the process gas used for the preparation of such materials. More specifically, it has been found that the tendency of a plasma deposited microcrystalline material to become more ordered, and hence have a larger grain size, may be suppressed if the composition of the process gas used for the preparation of the semiconductor material is controlled as a function of the increasing thickness of the layer.

Much of the subsequent disclosure of the present invention is devoted to the details of how such a result can be achieved.

Missing from the Examiner's anticipation rejection is any cogent explanation of how or where the Guha reference teaches controlling the process parameters in the manner claimed in

claim 1 to optimize the characteristics of the microcrystalline layer so produced. Instead, the Examiner makes the species assertion that the teaching of Guha et al. found in column 6, lines 20-53, is to control the process parameters to produce a microcrystalline layer, where in actual fact, '461 controls the process to produce a microcrystalline layer. Accordingly, the Examiner's §102(b) rejection over this reference is fatally flawed and should be reversed.

C. <u>Guha et al. Teaches Away from the Present Invention</u>

Furthermore, far from suggesting the process of claim 1, Guha '461 directly teaches away from it. Whereas the '461 patent teaches that it is necessary to decrease the dilution of the process gas as an amorphous semiconductor layer is grown so as to keep the layer amorphous and prevent it from becoming microcrystalline (column 6, lines 39-44), the present invention teaches the preparation of a microcrystalline semiconductor layer by decreasing the dilution of the process gas as the microcrystalline layer grows so as to maintain the deposition of a high quality microcrystalline layer.

Clearly, the teaching of the '461 patent and the teaching of the present invention are directly opposite. This evidences the fact that the two are directed to very different deposition processes. Specifically, the '461 patent shows the preparation of amorphous material and teaches control of the deposition process to avoid preparing microcrystalline materials, and further teaches that such control involves dilution of the process gas. In contrast, the present application is directed to the deposition of high quality microcrystalline semiconductor materials and teaches control of the process gas composition so as to maintain the high quality of the microcrystalline material.

The teachings of Guha '461 versus the teachings of the present invention cover diametrically opposed technologies. Therefore, the '461 patent does not show or suggest the

claimed principles of the present invention. In fact, any teaching to be gleaned from the Guha et al. reference is directly opposite, and away from, the principles of the present invention since the patent teaches methods for **preventing microcrystalline semiconductor growth** while the present application teaches principles for **encouraging microcrystalline semiconductor growth**.

In view of the foregoing, Appellants respectfully submit that the present claimed invention is neither shown nor suggested in the Guha et al. reference, and any possible rejections under 35 U.S.C. §103 are inappropriate.

D. Conclusion.

Appellants have provided a detailed explanation of the present invention, its advantages, and its distinctions over prior art processes taught by Guha '461. The Examiner has cited to no teaching at all in the prior art showing or suggesting that superior quality microcrystalline semiconductor materials can be prepared in the plasma deposition process by varying the concentration of a diluent in the process gas as a function of the thickness of the depositing layer of microcrystalline semiconductor material. Since the Examiner has completely failed to make such a showing, she has not presented even a *prima facie* case of either anticipation by Guha et al. or obviousness over the reference, either taken singly or in combination with any other reference of record. Accordingly, the Examiner's §102(b) rejection of claim 1 and claims 2-13 dependent thereon should be reversed, as well as the §103 obviousness rejections which are based upon the Guha et al. patent.

VIII. CLAIMS

A copy of the claims involved in the present appeal is attached hereto as Appendix A. As indicated above, the claims in Appendix A do include the amendments filed by Applicant on March 14, 2006.

Dated: November 30, 2006

Respectfully submitted,

By ____________________

Judith M. Riley
Registration No.: 31,561
GIFFORD, KRASS, GROH, SPRINKLE, ANDERSON & CITKOWSKI, P.C.
2701 Troy Center Drive, Suite 330
Post Office Box 7021
Troy, Michigan 48007-7021
(248) 647-6000
(248) 647-5210 (Fax)

Attorney for Appellants

APPENDIX A

Claims Involved in the Appeal of Application Serial No. 10/765,435

1. A process for the plasma deposition of a layer of microcrystalline semiconductor material, wherein a process gas which includes a precursor of the semiconductor material and a diluent is energized with electromagnetic energy so as to create a plasma therefrom, which plasma deposits a layer of said microcrystalline semiconductor material onto a substrate, wherein the improvement comprises:

varying the concentration of the diluent in said process gas as a function of the thickness of the layer of microcrystalline semiconductor material which has been deposited.

2. The process of claim 1, wherein the concentration of said diluent is decreased as the thickness of said layer increases.

3. The process of claim 1, wherein the concentration of said diluent is varied in a stepwise manner as the thickness of said layer increases.

4. The process of claim 1, wherein the concentration of said diluent is varied as a continuous function of the thickness of the layer.

5. The process of claim 1, wherein said microcrystalline semiconductor material includes a group IV element.

6. The process of claim 1, wherein said process gas comprises a member selected from the group consisting of: SiH_4, Si_2H_6, GeH_4, SiF_4, GeF_4 or combinations thereof.

7. The process of claim 1, wherein said diluent is selected from the group consisting of hydrogen, deuterium, a halogen or combinations thereof.

8. The process of claim 4, wherein said diluent comprises hydrogen.

9. The process of claim 1, wherein said electromagnetic energy is microwave energy.

10. The process of claim 1, wherein said electromagnetic energy is radiofrequency energy.

11. The method of claim 1, wherein the step of varying the concentration of the diluent in the process gas comprises changing the amount of the diluent in said process gas.

12. The method of claim 1, wherein the step of varying the concentration of the diluent in the process gas comprises changing the amount of the semiconductor precursor in the process gas.

13. The process of claim 1, including the further step of varying at least one other deposition parameter as a function of the thickness of the layer of microcrystalline semiconductor material which has been deposited, said other deposition parameter being selected from the group consisting of: process gas pressure, power density of said electromagnetic energy, frequency of said electromagnetic energy, or substrate temperature.

14. The process of claim 1, wherein said semiconductor material includes silicon and germanium therein and wherein said process gas includes a silicon-containing compound, a germanium-containing compound, and a diluent selected from the group consisting of hydrogen, deuterium or combinations thereof, and wherein the ratio of said silicon-containing compound to said germanium-containing compound is varied while said semiconductor material is being deposited so that the silicon/germanium ratio of said layer of semiconductor material varies as a function of layer thickness; and wherein the concentration of said diluent gas in the process gas is increased as the ratio of said germanium-containing compound to said silicon-containing compound therein increases.

APPENDIX B

No evidence pursuant to §§ 1.130, 1.131, or 1.132 or entered by or relied upon by the examiner is being submitted.

APPENDIX C

No related proceedings are referenced in II. above, hence copies of decisions in related proceedings are not provided.